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MECHANICS

Course of Studies

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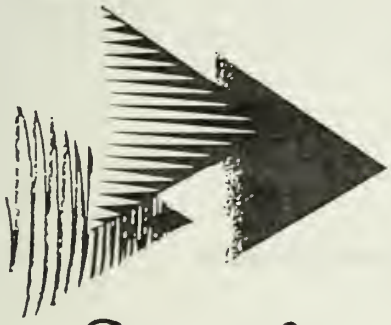
1993–94 Field Review

- Introductory Level



Career & Technology STUDIES

JULY 1993

Alberta
EDUCATION
CURRICULUM BRANCH

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MECHANICS

A. STRAND RATIONALE

The movement of people and goods from one place to another has always been important to human existence. Significant advancements have occurred in the development of transportation modes over the last century which have dramatically altered the way we live and make our living. However, the quick and convenient movement of people and goods is not risk free. The ever-increasing use of motor vehicles throughout the world and their reliance on fossil fuels has created major personal safety and environmental concerns. Because the transportation industry is very large and diverse, there are many opportunities for a rewarding career, whether it be to design and build safer and more efficient vehicles or to service the ones that are already in use.

Mechanics is a strand within the Transportation Studies area. Through hands-on experiences, students have the opportunity to increase their knowledge and skills related to the design and maintenance of transportation vehicles, and the impact they have on the environment and on our economic and social well-being. Whether a student plans to prepare for a work-related role in the industry or wants to simply be an informed owner/operator of a vehicle, Mechanics should be viewed as an educational opportunity for all secondary students.

More specifically, the Mechanics strands will provide students with a broad base of experience related to the transportation field, which will enable them to:

- develop problem-solving and decision-making skills
- develop estimating and reporting skills
- become better informed consumers
- build leadership and teamwork skills
- develop technological and manual skills
- identify further education and career opportunities
- exercise safe work and environmental practices.

B. STRAND ORGANIZATION

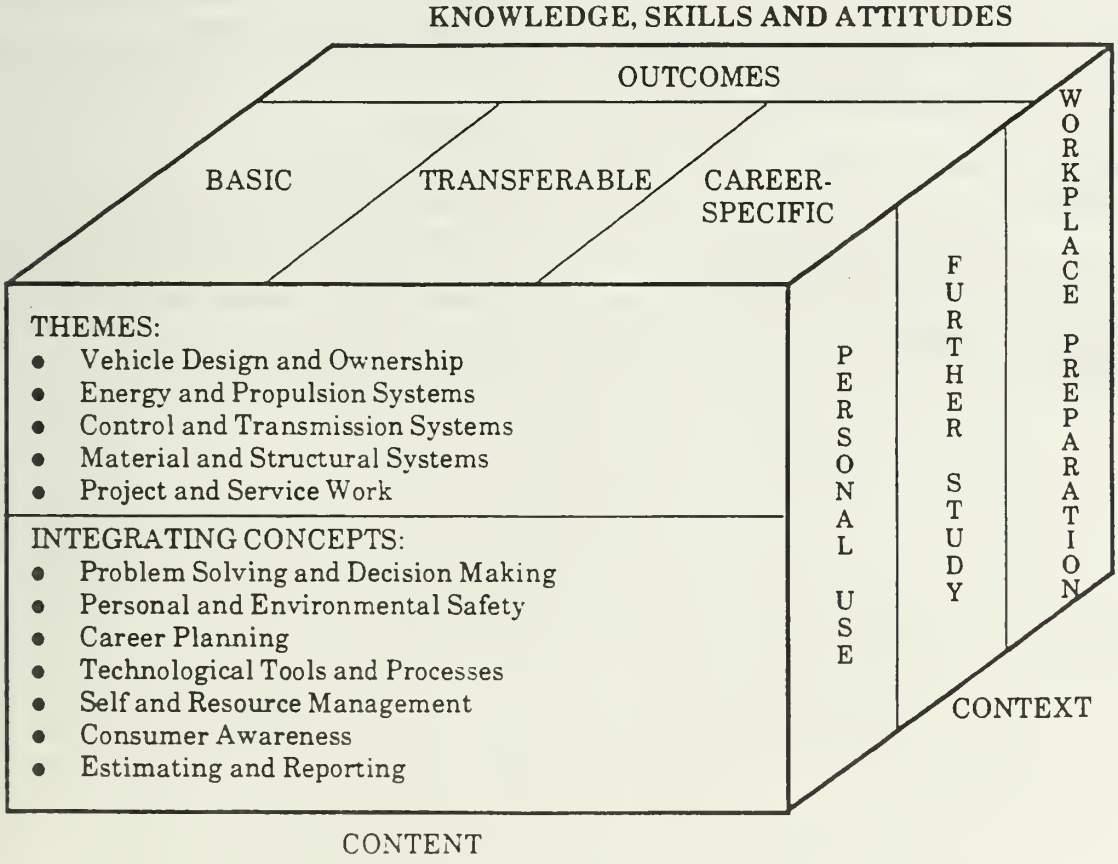
CURRICULUM STRUCTURE

Mechanics, like other Career and Technology Studies curricula, has been developed using a modular design. A module is a unit of curriculum that should be achieved by the majority of students in approximately 25 hours of learning.

The Mechanics curriculum is organized into three levels of learning: introductory, intermediate and advanced. The Mechanics strand begins with exploratory activities for junior high school studies. It becomes more specialized and demanding as the students progress, during high school, towards the intermediate and advanced level modules. The introductory level contains modules that will help students build daily living skills and form the basis for further learning. Introductory modules are developed for students who have no previous experience in the strand. The intermediate level contains modules that build on competencies developed in the introductory level and focus on developing more complex, transferable competencies. The advanced level contains modules that require a higher degree of expertise and focus on developing specific competencies required for entry into the workplace or a related post-secondary program.

DEVELOPMENT MODEL

The Mechanics curriculum model has been developed around five themes, discussed below, which relate specifically to the design, operation and care of transportation vehicles. These themes are integrated by a number of common topics, which provide a basic framework for the study of each module. The context in which the learning takes place will vary according to the experience and intent of the learner. As the learner is engaged in the learning activities, specific outcomes are anticipated. These outcomes will take the form of basic, transferable and career-specific knowledge, skills and attitudes constructed by the learner.



THEMES

Each level of Mechanics has major themes on which modules have been developed:

- vehicle design and ownership
- energy and propulsion systems
- control and transmission systems
- material and structural systems
- project and service work.

PROGRAM PLANNING

The Mechanics curriculum framework ensures that students do not repeat content. Schools and teachers have maximum flexibility to design programs based on the needs and interests of their students and circumstances in the school and community. The levels framework will challenge students to keep learning and will provide new and exciting opportunities at each level.

Teachers will select three or more modules to design a course. Criteria that should be considered in designing course sequences are:

- student interests, abilities and career aspirations
- expertise and interests of the teacher
- potential linkages with other school programs.

Sample

The following is an example of a 3-credit course:

MODULES
• Concept Vehicle Design and Construction (MEC101) • Mechanical Systems (MEC112) • Engine Fundamentals (MEC104)
RATIONALE/LEARNINGS
Students use problem-solving skills to construct a model or mock-up of a vehicle, identify and work with mechanical systems used to transmit and control power, and discover the operating principles of a propulsion system. This course complements the mathematics and science programs as well as Design Studies and Transporting People and Goods. It gives students the opportunity to develop skills related to the use of materials and hand tools.

LINKAGES

The content of the program has strong ties to core and other complementary course. Some modules being developed may be beyond the resources of some schools; therefore, for parts of the program it may be necessary for the student to access community resources.

MECHANICS SCOPE AND SEQUENCE

INTRODUCTORY	INTERMEDIATE	ADVANCED	Theme
Concept Vehicle Design and Construction	Vehicle Detailing	Buying and Selling a Vehicle	Vehicle Design and Ownership
Vehicle Service and Care	Vehicle Maintenance		
	Lubrication and Cooling System	Engine Trouble Shooting	Energy and Propulsion Systems
Engine Fundamentals	Fuel and Exhaust Systems	Engine Blue Printing	
	Alternate Fuel Systems	Engine Repair	
	Ignition Systems	Engine Rebuilding	
		Alternate Propulsion Systems	
Electrical Systems	Electrical Accessories	Computer Management Systems	Control and Transmission Systems
		Safety Systems	
Pneumatic and Hydraulic Systems	Braking Systems	Climate Control	
	Hydraulic Accessories	Power Assisting	
Mechanical Systems	Power Trains	Automatic Transmissions	
	Manual Transmissions	Power Train Removal and Repair	
Ride and Control Systems	Suspension Systems	Wheel Alignment	
	Steering Systems		
	Metal Forming and Finishing	Structural Damage and Analysis	Material and Structural Systems
Vehicle Structure and Materials	Plastic Bonding and Welding	Structural Damage Repair I	
	Fibre Reinforced Components	Structural Damage Repair II	
	Basic Touch-up and Finishing	Trim Removal and Installation	
	Interior Finishes and Repairs	Surface Preparation	
	Upholstery Repairs	Refinishing	
	Mechanics Project	Mechanics Project	Project and Service Work
	Mechanics Project	Mechanics Project	
		Mechanics Project	
		Mechanics Project	

MODULE DESCRIPTIONS

Module MEC101: Concept Vehicle Design and Construction
The student researches, designs, builds and tests a model of a transportation vehicle using a simple power source, common materials and tools.

Module MEC102: Vehicle Service and Care
This module is designed to help the student understand and take responsibility for the care and service of a motor vehicle.

Module MEC104: Engine Fundamentals
In this module, the student investigates and describes principles of engines, their construction and applications.

Module MEC108: Electrical Systems
This module focuses on the operating principles and applications of electrical systems used to transmit and control electricity.

Module MEC110: Pneumatic and Hydraulic Systems
This module focuses on the operating principles and applications of pneumatic and hydraulic systems used to transmit and control fluid energy.

Module MEC112: Mechanical Systems
This module focuses on the operating principles and applications of mechanisms that are used to transmit and control mechanical energy.

Module MEC114: Ride and Control Systems
In this module, the student identifies the types of materials and parts that are used in a vehicles' construction and considers ways to recycle these materials once a vehicle has been taken out of service.

C. CURRICULUM AND ASSESSMENT STANDARDS

CURRICULUM STANDARDS

Curriculum standards are expressed through learner expectations, which describe the competencies students are expected to achieve as they progress through the Mechanics program.

Throughout this course of studies, the learner expectations are described in three progressively detailed stages: strand, module and specific learner expectations.

Strand Learner Expectations

Strand learner expectations describe the overall results to be achieved by the student in Mechanics. To accomplish these desired outcomes, *the student will:*

- develop the knowledge, skills and attitudes in the context of the school and community to achieve success in personal and work life
- apply effective and responsible decision-making strategies in the design and repair of transportation vehicles
- link the knowledge, skills and attitudes developed in other courses in meaningful and practical ways to the field of mechanics
- demonstrate flexibility, cooperative work behaviours, and effective communication and leadership skills
- link theory and practice using resources, tools and materials responsibly and efficiently
- expand personal knowledge and appreciation of career options and opportunities related to the transportation industry
- determine the economic significance of the transportation industry in the local, national and global community.

Module Learner Expectations

Module expectations describe the outcomes to be achieved by the learner for a particular module. These are stated at the beginning of each module.

Specific Learner Expectations

Specific learner expectations describe the expected results for each topic covered in the module. These expectations become the building blocks for the development of the module and strand learner expectations. Specific learner expectations for introductory level modules in Mechanics are identified on pages 9 through 28.

ASSESSMENT STANDARDS

Assessment standards describe the conditions and criteria for determining whether or not a student's performance meets the required standard.

MODULE MEC101: CONCEPT VEHICLE DESIGN AND CONSTRUCTION

Level: **Introductory**

In this module, the student researches, designs, builds and tests a model of a transportation vehicle using a simple power source, common materials and tools.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • research and design a transportation vehicle for specific need and application	For a transportation mode, *the student will:* • devise a plan to construct a prototype vehicle using a simple propulsion device, available materials and tools • be assessed on the: – extent to which problem-solving principles are used – clarity and creativity demonstrated in two or more thumbnail sketches – construction details and quality of working drawings for one concept vehicle	30
• use tools and materials in an appropriate fashion to construct and test the performance of a vehicle for its intended use	• use available tools and materials to safely construct and test performance of a prototype vehicle • be assessed on the: – consistent, safe use of materials and tools – degree to which construction details and tolerances have been met – extent to which form and finish are appropriate to the function of the vehicle – efficient use of time and resources – ability to work cooperatively with others	60
• describe the basic operation of a concept vehicle.	• identify and describe the operation of the propulsion transmission and control system used in a vehicle of choice • be assessed on the: – accurate identification of operating principles – reporting techniques.	10

Specific Learner Expectations

Concept	Specific Learner Expectations
Creating and Controlling Motion	*The student will:* • describe the forces that are to be overcome when a vehicle moves: – on land – in water – in air – in space • demonstrate and describe how energy can be used to produce motion using a: – spring – elastic – CO_2 capsule – electromagnetic device • determine what techniques can be used to: – start and stop a vehicle – speed up and slow down a vehicle – control the direction of a vehicle – give a vehicle stability.
Creating a Design	• use thumbnail sketches to produce a concept drawing of vehicle's design and construction • use drawing instruments to produce a working drawing of a concept vehicle.
Creating a Prototype Model	• choose the appropriate materials to construct a prototype by considering their: – workability – strength – weight – cost • safely construct the vehicle according to the specification and working drawing • apply a finish to the vehicle to: – enhance its appearance – increase its performance – increase its longevity.

Concept	Specific Learner Expectations
Testing	• test the vehicle individually or in competition with others in relation to its intended use such as: – speed – pay load – pulling power – maneuverability – altitude – or combination of characteristics.

MODULE MEC102: VEHICLE SERVICE AND CARE

Level: Introductory

This module is designed to help the student understand and take responsibility for the care and service of a motor vehicle.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • create a service schedule for a vehicle as a means of preventive maintenance	*The student will:* • prepare a service schedule that is in keeping with: – the manufacturer's recommendations – local driving conditions – use of the vehicle	
• inspect and service a vehicle as outlined in the vehicle service schedule	• complete a vehicle inspection and service the major mechanical components according to the service schedule and the manufacturer's recommendations	
• thoroughly clean and apply a protective coating to the exterior and interior surfaces of a vehicle in preparation for use or storage.	• select the appropriate products and restore the surfaces of a vehicle to a "like new" condition within the allotted time and according to the product and vehicle manufacturer's recommendations.	

Specific Learner Expectations

Concept	Specific Learner Expectations
Rationale	*The student will:* • explain why preventive maintenance can: – avoid expensive repairs – improve reliability and safety – improve efficiency – extend the life of the vehicle.
Vehicle Components and Systems	• identify and locate a vehicle's major mechanical and structural components that need regular service and care.
Routine Vehicle Inspection	• complete a visual inspection of: – fluid levels – hose and belt condition – tire pressure and condition – lights and accessories – battery condition.

Concept	Specific Learner Expectations
Service Schedules and Records	*The student will:* • use the owner's manual or a shop manual to determine when to: – change lubrication fluids – replace filters – drain and replace coolants – lubricate body components – inspect and lubricate suspension and steering joints – inspect brake linings – repack bearings – rotate tires.
Replacement Parts and Products	• determine from the owner's manual the recommended: – type and grade of motor oil – type of engine coolant – brake fluid – power steering fluid – transmission fluid – type of air, oil and fuel filters.
Vehicle Repairs	• determine what type of repairs can be safely done by a novice • determine what to look for in a good service centre and technician.
Vehicle Servicing	• demonstrate the procedures used to: – replace engine motor oil, coolant and filters – lubricate chassis and body parts – clean and check the battery condition – rotate tires – check the pressure – dispose of used fluids and parts.
Vehicle Operation	• identify trouble signs such as: – warning lights or gauges – unusual odors or noises – fumes – leaks.
Cosmetic Care	• identify and demonstrate the use of products that can be safely used to: – clean a painted surface – degrease components – wax and polish a surface – touch-up chipped surfaces.

Concept	Specific Learner Expectations
Vehicle Storage and Shelter	*The student will:* • determine what steps should be taken when a vehicle is going to be stored for a period of time • explain why it is necessary to shelter or protect a vehicle from: – the sun's radiation – salt water – heat and cold.

MODULE MEC104: ENGINE FUNDAMENTALS

Level: **Introductory**

In this module, the student investigates and describes principles of engines, their construction and applications.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • analyze and compare the operating principles of common engines	*The student will:* • given two different types of engines, describe their operation by contrasting and comparing the: – type of fuel and fuel delivery system – combustion location – type of burn cycle – method of ignition, lubrication and cooling – efficiency of the engine	20
• apply the appropriate diagnostic practice to determine the overall condition of an internal combustion engine	• given a light industrial or a small motor vehicle internal combustion engine, examine its operating history and investigate for incorrect adjustments, and worn or defective parts by referring to the manufacturer's specifications	60
• be aware of the by-products of combustion and their impact on the environment.	• for a specific fuel and engine type, list the emissions and describe their effects on the health of individuals and the environment.	20

Specific Learner Expectations

Concept	Specific Learner Expectations
Conversion of Heat to Motion	*The student will:* • observe the effects of heating a gas in an enclosed space • identify the types of fuels commonly used in combustion engines • describe the by-products of combustion and their effects on health and the environment.
Engine Types	• describe the difference between an internal and an external combustion engine • identify the type of engines and fuels that are used for air, land, sea and space applications.

Concept	Specific Learner Expectations
Reciprocating Engines	*The student will:* • recognize and label the major parts of a reciprocating engine • demonstrate how reciprocating motion is converted to rotary motion • examine and explain the difference between a two- and a four-stroke cycle engine.
Engine Systems	• explain the purpose of the following support systems: – cooling – lubrication – ignition – fuel – exhaust.
Engine Description	• demonstrate how engines differ according to their: – number of cylinders – design – size – make and model • apply the data to locate: – service bulletins and repair manuals – engine specifications – part numbers and assembly details.
Engine Service and Repair	• describe the hazards associated with: – gasoline and other flammable liquids – exhaust gases – hot coolants • use hand tools and test equipment as intended • determine the condition of an engine, adjust, service and replace defective parts where necessary.

MODULE MEC108: ELECTRICAL SYSTEMS

Level: **Introductory**

This module focuses on the operating principles and applications of electrical systems used to transmit and control electricity.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • describe and apply the principles and concepts related to the use of electricity to produce, transmit and control energy	*The student will:* • be familiar with basic electrical circuit drawings and symbols • effectively demonstrate the production of electricity by mechanical, chemical, thermal and photoelectrical means and provide an example for each one of these from a motorized vehicle • use simple sketches and constructions to demonstrate the use of electrical systems to change the size, direction and use of an electrical force • accurately predict the effects that a change in voltage, amperage or resistance will have on a circuit	
• understand the need to exercise caution when working with electricity.	• consistently follows lab routines and safety measures.	

Specific Learner Expectations

Concept	Specific Learner Expectations
Magnetism and Electricity	*The student will:* • observe and describe magnetic attraction and repulsion between two magnets • produce a temporary and permanent magnet • determine the polarity of an electromagnet.
Electricity and the Atom	• describe the electron theory in relation to the parts of an atom.

Concept	Specific Learner Expectations
Producing Electricity	*The student will:* • observe and describe production of electricity: – statically – chemically – thermally – photoelectrically – piezoelectrically – electromagnetically • explain the difference between AC and DC current.
Electrical Circuits	• identify and label the parts of a simple circuit • recognize the physical form and circuit symbol of a: – light – motor – heating element – solenoid – fuse • construct and compare a series and a parallel circuit • determine what conditions create: – an open circuit – a closed circuit • describe how a frame-ground circuit operates on a motor vehicle.
Electrical Measurement	• define what is meant by: – amperage – voltage – resistance • compare these factors to a fluid system • measure the resistance voltage and amperage in a given circuit given the appropriate meters • determine the relationship that exists between the amperage, voltage and resistance within a circuit.
Career Exploration	• determine what skills are required to diagnose electrical problems in a modern vehicle.

MODULE MEC110: PNEUMATIC AND HYDRAULIC SYSTEMS

Level: **Introductory**

This module focuses on the operating principles and applications of pneumatic and hydraulic systems used to transmit and control fluid energy.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • describe and apply the principles and concepts related to the use of pneumatic and hydraulic systems to transmit and control energy	*The student will:* • be familiar with basic pneumatic and hydraulic symbols and circuit drawings • use simple sketches and construction to demonstrate the use of pneumatics and hydraulic systems to change the size, direction and location of a fluid force • accurately predict the flow rate in an enclosed system	
• compare and contrast the operating principles of pneumatic and hydraulic systems	• list the differences and similarities between hydraulic and pneumatic systems	
• understand the need to exercise caution when working with hydraulic and pneumatic components.	• consistently follow lab routines and safety measures.	

Specific Learner Expectations

Concept	Specific Learner Expectations
Fluid Systems	*The student will:* • state why fluid systems are widely used in transportation and power applications • contrast hydraulic and pneumatic systems • know the hazards related to working with fluids under pressure and related equipment.
Fluids under Pressure	• observe and demonstrate how pressure affects a liquid and a gas in an enclosed space • determine what units are used to measure pressure in a fluid.

Concept	Specific Learner Expectations
Fluids in Motion	*The student will:* • determine what units are used to calculate the flow of fluid past a point • demonstrate the relationship between flow rate and pressure in a fluid system.
Developing Fluid Power	• contrast the action of common pumps and compressors such as: – impeller – gear – piston – diaphragm – vane type • locate examples of these pumps and compressors in a motor vehicle or some other power system.
Controlling Fluid Power	• observe and demonstrate the use of valves to control the: – direction of fluid motion – pressure of fluids – flow rate of fluids.
Using Fluid Power	• observe and demonstrate how fluids under pressure can be used to move a: – motor – cylinder – diaphragm.
Increasing Force with Fluids	• examine how a small force can be multiplied in a fluid system • describe the principles in a fluid system such as: – hydraulic hoist – hydraulic brakes.
Career Exploration	• consider the widespread use and need to design and maintain fluid systems.

MODULE MEC112: MECHANICAL SYSTEMS

Level: **Introductory**

This module focuses on the operating principles and applications of mechanisms that are used to transmit and control mechanical energy.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • describe and apply the principles and concepts related to the use of mechanisms to control and transmit force and motion in a vehicle	*The student will:* • identify and use simplified sketches to illustrate the use of mechanisms to change the size, direction and location of mechanical force • accurately determine the velocity ratio, gear ratio, torque and efficiency of a mechanical system • accurately calculate the coefficient of friction between two materials • identify at least two methods to increase or decrease the amount of friction between two parts	
• exercise caution when working with tools and moving parts	• consistently follow lab routines and safety measures	
• assess the importance of being able to use simple machines in daily life and/or in work.	• prepare a 200–300 word report, complete with illustrations and charts, showing how simple machines are used in daily life and/or in work.	

Specific Learner Expectations

Concept	Specific Learner Expectations
Mechanical Systems	*The student will:* • recognize that mechanical systems are found in all aspects of human endeavour • demonstrate the use of simple machines to change the: – direction in which a force acts – size of the force – place where the force acts.
Kinds of Mechanical Motion	• devise or locate a mechanism that produces: – linear motion – reciprocating motion – oscillating motion – rotary motion

Concept	Specific Learner Expectations
Kinds of Mechanical Motion (continued)	*The student will:* • observe and graph the action of a cam as it changes rotary motion to linear motion.
Direct Power Transmission	• explain the difference between direct and indirect transmission of power • describe the purpose and types of: – shafts – couplers – universal joints – pins.
Indirect Power Transmission and Control Using Simple Machines	• observe and demonstrate the use of simple machines to: – start and stop motion – change directions – increase or decrease speed – increase or decrease torque • describe the relationship between torque and velocity/gear rations in a mechanical system.
Friction	• explain why friction has both positive and negative attributes • determine the coefficient of friction between two materials • determine how friction can be increased or decreased in a mechanical system.
Efficiency	• calculate the idea and actual mechanical advantage of one or more mechanisms to determine the efficiency of the system.
Converting Mechanical Energy	• explain how mechanical energy can be change to – heat energy – electrical energy – fluid energy in a transportation vehicle.

MODULE MEC117: VEHICLE STRUCTURES AND MATERIALS

Level: **Introductory**

In this module, the student identifies the types of materials and parts that are used in a vehicle's construction and considers ways to recycle these materials once a vehicle has been taken out of service.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • identify the basic parts and materials used in the construction of a vehicle	*The student will:* • use a variety of strategies to determine the type of materials used in a specific make and model of vehicle • be assessed on the: – appropriate use of magnetic and physical tests – accurate interpretation of codes and manufacturer's documents – extent to which appropriate terminology and dismantling techniques are used	
• determine the relationship between the function of a vehicle and the materials used in its construction	• list and explain why a particular material is used in the construction of a given part of structure • be assessed on the identification of such factors as: – cost of manufacturing – strength to weight ratios – desired length of service – ease of maintenance	
• be conscious of personal hazards and government regulations that are associated with the repair and recycling of vehicle parts.	• identify local and provincial laws that regulate the repair and disposal of vehicle parts and structures as they relate to the health and the environment • be assessed on the: – knowledge of government regulations and local by-laws – demonstrated safe handling, use and disposal of hazardous materials.	

Specific Learner Expectations

Concept	Specific Learner Expectations
History of Materials Used in Transportation Vehicles	*The student will:* • trace the historical development of materials used in transportation vehicles • identify and discuss the factors that have contributed to the use and development of new structural materials.
Material Identification and Selection	• identify the monoliths and composite materials used in a modern vehicle • determine the most appropriate methods for identifying the type of materials used in a part of structure • identify the factors used to select a material for a given function.
Structural Engineering	• suggest how the purpose and the media a vehicle operates in affects its design and construction • identify design features that are tied more closely to consumer taste than function • list ways government regulations have altered the design and construction of vehicles • examine a vehicle and describe what steps have been taken to: – reduce its weight – reduce drag – increase passenger safety – increase longevity of structural parts – improve passenger comfort and space.
Structural Coatings and Seals	• identify what coatings are used to: – protect against corrosion – add to the appearance – reduce effects of the sun's radiation – reduce noise • take note of the health and environmental issues related to the replacement and repair of coated surfaces.
Recycling	• determine what parts of a vehicle are recyclable • cite examples of initiatives that will increase the percentage of parts that can be recycled.
Career Exploration	• identify growth occupations that are associated with designing, building, repairing and recycling transportation vehicles.

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